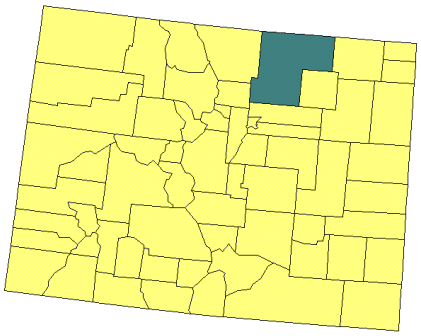
Improved Secondary Recovery Demonstration for the Sooner Unit -- Class I

Diversified Operating Corp



Muddy (D) Formation — Sooner Unit

@ 6, 300 ft. — Weld County, CO

Cretaceous Age — Denver-Julesburg Basin

DE-FC22-93BC14954

Contract Period:
10/21/1992 to 11/30/1995

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Objective: The objectives of the project are to demonstrate the cost-effectiveness of geologically targeted infill drilling and improved reservoir management to increase waterflood recovery of the Cretaceous Muddy 'D' formation in the Denver-Julesburg Basin, northeast Colorado.

Technologies Used: 3-D seismic imaging, selective infill drilling and reservoir management, reservoir simulation, transient well tests, production tests, multidisciplinary reservoir characterization.

Background: The Cretaceous 'D' Sand has good primary recovery but disappointing waterflood performance. The majority of waterflood projects have produced only about 20% of the OOIP. Several previous waterflood projects in the general vicinity of the Sooner Unit had marginal to negative incremental reserves compared to primary production extrapolations. Poor waterflood recovery is attributed to reservoir heterogeneity and poor reservoir management practices. Three-dimensional seismic had not been used in the D-J Basin for exploration or development of 'D' Sand reservoirs prior to this project.

Incremental Production: As of February, 1996 daily production from the Sooner Unit has increased more than 100% above the trend established before the project was initiated. Incremental proved-producing reserves attributed to activities performed during the project is placed at 305,000 bbl. Recovery had been boosted from 15% OOIP to 20% by mid 1996. Follow-up field experiments with gel injection for profile modification is expected to boost production to as much as 30% OOIP.

Expected Benefits and Applications: The use of 3-D seismic data analysis techniques to identify reservoir architecture and tailoring well spacing and injection patterns to the reservoir compartments can be applied to many fields in the D-J Basin to increase waterflood recovery. The project demonstrates the use of under-utilized technologies for achieving economical secondary oil production in an area where waterflooding has been uneconomical. Project demonstrates the use of under-utilized technologies for achieving economical secondary oil production in an area where waterflooding has been uneconomical.

Accomplishments: A seismic attribute correlation technique that successfully quantified prediction of gross and net pay thickness was developed. The project was successful in demonstrating that reservoir development methodology can be used for selective infill drilling based on reservoir compartments. This project has demonstrated that waterflooding can yield secondary oil equal to that obtained by primary depletion in the Sooner 'D' Sand Unit. An effective tool for targeting infill and edge locations has been developed using attribute correlation of 3-D seismic with petrophysical data. The 3-D survey at the Sooner Unit has precipitated an additional 13 3-D surveys in the D-J Basin for the purpose of 'D' Sand development and exploration

Publications: (1) Sippel, M.A., D.S. Singdahlsen, "Waterflood Success at the Sooner 'D' Sand Unit," Petroleum Technology Transfer Council workshop, entitled Reservoir Characterization: Does it Help? Case Studies of 3 Fields in Eastern Colorado, November 17, 1995, Denver, Colorado. (2) Sippel, M.A., D.S. Singdahlsen, "Advanced Secondary Recovery Demonstration for the Sooner Unit," presented at the DOE-PTTC traveling Technology Workshops series, January-February 1996. (3) Montgomery, S.L., 1997, "Sooner Unit, Denver Basin, Colorado: Improved waterflooding in a fluvial-estuarine reservoir (Upper Cretaceous D sandstone)": AAPG Bulletin, Vol. 81, No. 12, p 1757-1974.

Recent/Upcoming Technology Transfer Events: Sippel, M., "Integration of 3-D Seismic to Define Functional Reservoir Compartments and Improve Waterflood Recovery in a Cretaceous Reservoir, Denver Basin": AAPG/EAGE Research Symposium, October 20-23, 1996 Houston, TX.

Project Status: Project completed. Final report published November 1996.